sented by the Carnegie Institution; J. A. Repsold, Geschichte der Astronomischen Messwerkzeuge, presented by Mr. Franklin-Adams; E. B. H. Wade, Field method of determining longitudes by observations of the Moon, presented by the Egyptian Survey Department.

Astrographic Chart; 32 charts, presented by the Royal Observatory, Greenwich; 20 charts, from Algiers and Paris Observatories, presented by the French Government; and 20 charts, presented by the San Fernando Observatory.

Series of 36 collotype reproductions of photographs of the Milky Way, etc., presented by Professor E. E. Barnard; photograph of the Nebula in Orion (transparency) from negative taken by Professor Perrine with the Crossley reflector, presented by the Lick Observatory.

A suggested explanation of the ancient Jewish Calendar Dates in the Aramaic Papyri translated by Professor A. H. Sayce and Mr. A. E. Cowley. By E. B. Knobel.

The Aramaic papyri discovered at Assuan, on the site of the ancient Syene, which have been recently translated and published by Professor Sayce and Mr. Cowley, are of unique interest and importance owing to the duplicate dates given to each document. These documents cover a large part of the fifth century B.C., extending from B.C. 471, nine years only after the battle of Salamis, to B.C. 410. The papyri all relate to a Hebrew colony established at that period at Syene, and deal with rights of property, conveyance of land and buildings, marriage portions, and legal processes. They are all deeds most carefully drawn, signed, sealed, and witnessed, and they are dated according to both the Egyptian and Hebrew calendars, in the regnal years of the kings of Persia.

The Egyptian year and calendar are well understood. The year was a vague solar year, and consisted of 365 days without intercalation or correction, consequently the Julian date of the commencement of the Egyptian year recedes one day every four years. The year consisted of twelve months, each of thirty days, and five additional days, called *epagomenæ*, were added after the last month. There is consequently no difficulty with this calendar in determining the corresponding Julian date.

Very little, however, is known of the Jewish calendar in use at the period under consideration. The present reformed calendar dates only from the time of Hillel in the fourth century A.D., though it was probably not finally settled until after the fifth century. It is known that in olden times the year was a lunar year, and certain months, and ordinances connected with the months and seasons, are mentioned in the Old Testament. There is no mention of an intercalary month in the Bible, and it is not

known whether the correction to the solar year was applied in ancient times by the addition of one month in three years, or by the adding of ten or eleven days at the end of each year. No information appears to exist that there was anything like a settled Jewish calendar so far back as the fifth century B.C.

It is very generally stated that prior to the adoption of the reformed calendar the Jews employed the era of the Seleucidæ, the years of which were Julian of 365 days, but this could not have been the case at the period under discussion. Burnaby's work on the Jewish calendar gives little assistance in the present investigation.

Mr. Margoliouth—a high authority—writes: "No lists of pre-Christian Jewish dates reconciled with Egyptian or other dates are so far available to throw light on the exact form of the calendar used for the dating of the Aramaic documents published by Professor Sayce and Mr. Cowley. In the fifth century B.C. the Jewish calendar depended entirely on the observation of the Sun and the Moon, particularly the latter. The decisions must have been made by a central court, as was practically the case down to 359 A.D., so that great uncertainty would be caused in distant parts (such as Syene in Upper Egypt, to which the papyri belong) by the delay in transmitting the announcements.

"It is also uncertain whether the Jewish lunar year was in ancient times harmonised with the solar year by the addition of one month in three years, or by lengthening the last month in each year. The difficulties connected with the dates given in the recently published papyri may possibly have to be ascribed to the uncertainties mentioned."

Professor Schürer has discussed the subject in the *Theologische Literaturzeitung* for February 1907, in which he claims that the papyri confirm the fact that the Jews began their months with the *appearance* of the new moon, and further that they show that "it was far from the case that any definite system had been adopted."

Dr. Lidzbarski has also reviewed these papyri in the *Deutsche Literaturzeitung* for 1906, but his discussion is more particularly philological, and contributes little towards the question of the ancient calendar of the Jews.

The object of the present paper is to inquire whether more definite information on the subject cannot be derived from the Aramaic papyri themselves.

The dates of each papyrus, as given by the translators, are as follows. The figures in brackets indicate possible alternative dates according as a certain slanting mark in the writing is considered as forming part of the numeral or not. The present opinion is that it should do so, and that the higher number is the correct one, which I have accordingly adopted.*

A. On the 17th (18th?) of Elul, that is the 27th (28th?) day of Pachons, the 14th (15th?) year of Xerxes the king . . . .

* An exception may probably be made in the day of Thoth in B.

B. On the 18th (?) of Chisleu, that is the 6th (7th?) day of Thoth, the 20th (21st?) year (of Xerxes), the beginning of the reign when Artaxerxes the king ascended his throne . . . .

C. Mutilated as to the dates.

D. On the 21st Chisleu, that is the 1st of Mesore, the 6th year of Artaxerxes the king . . . .

E. On the 3rd of Chisleu, that is the 10th day of the month Mesore, the 19th year of Artaxerxes the king . . . .

F. On the 13th (14th?) of Ab, that is the 19th day of Pachons, the 25th year of Artaxerxes the king . . . .

G. On the 26th (?) of Tishri . . . . the 6th (day) of the month Epiphi [the 25th year of Artaxerxes the king] . . . .

H. In the month Elul, that is Payni, the 3rd (4th?) year of Darius the king.

J. On the 3rd of Chisleu, the 7th (8th?) year, that is the 11th (12th?) day of Thoth, the 7th (8th?) year of Darius the king . . . .

K. On the 23rd (24th?) of Shebat, the 13th year, that is the 8th (9th?) day of Athyr, the 13th (14th?) year of Darius the king . . . .

The dates definitely adopted from the translation are as follows:—

A.	15th year of	Xerxes,	28th Pachons	=	18th Elul.
B.	1st ,,	Artaxerxes,	6th Thoth	=	18th Chisleu.
E.	19th ,,	,,	10th Mesore	=	3rd Chisleu.
F.	25th ,,	,,	19th Pachons	=	14th Ab.
J.	8th ,,	Darius,	12th Thoth	=	3rd Chisleu.
K.	14th ,,	,,	9th Athyr	=	24th Shebat.

For the regnal years of the kings I have adopted the dates given by Ricard in his edition of Plutarch, thus:—

Cambyses,	1st year	B.C.	529
Smerdis (7 months),*	,,	,,	522
Darius Hystaspes,	,,	,,	521
Xerxes the Great,	,,	,,	485
Artabanus (7 months),	,,	,,	464
Artaxerxes Longimanus,	,,	,,	464
Xerxes II. (a month),	,,	,,	425
Sodgianus (7 months),	,,	,,	424
Darius II. (nothus)	,,	,,	423

The order of the Egyptian and Hebrew months is as follows:—

Egyptian Months.	Days.	Hebrew Months.	Days.
Thoth.	30	Tishri.	30
Phaophi.	30	Marheshvan.	29 or 30
Athyr.	30	Chisleu.	30 or 29
Choiak.	30	Tebeth.	29
Tybi.	30	Shebat.	30
Mechir.	30	Adar.	29

* Oppert.

Egyptian Months.	Days.	Hebrew Months.	Days.
Phamenoth.	30	Ve-Adar.	30
Pharmuthi	30	Nisan.	30
Pachons.	30	Iyyar.	29
Payni.	30	Sivan.	30
Epiphi.	30	Tammuz.	29
Mesore.	30	Ab.	30
5 Epagomenæ.		Elul.	29

In the papyri the Julian dates corresponding to the Egyptian dates are all known, and the problem, in the absence of all information on the subject, is to construct a reasonable and probable Jewish calendar which shall satisfy all the Jewish dates.

Fortunately the papyri E. and J. offer some assistance towards the solution of this difficult question. The Egyptian dates in Julian reckoning are as follows:—

E. B.C. 446 ... 10th Mesore = November 17,
J. B.C. 416 ... 12th Thoth = December 16,

but the Jewish date of both documents is the same, viz. 3rd Chisleu; consequently the period B.C. 446 November 17 to B.C. 416 December 16 should be an *exact number* of Jewish years.

It has been assumed by writers generally that the commencement of each month was determined by observation and announcement, and this was no doubt the common practice in the ecclesiastical year, which began with the 1st Nisan. The Jewish civil year, however, began unquestionably with the 1st Tishri; and with such a practical business people as the Jews, who, as we should infer from the papyri under consideration, enjoyed at this period a high state of civilisation, it is almost inconceivable that they should not have had in current use some calendar upon which they could base their business negotiations.

The reformed Jewish calendar is based upon the Lunar cycle of nineteen years—the so-called Metonic cycle—and it is not unreasonable to assume that this cycle was in use with the Jews long before the time of Hillel. With one exception, that of the French Revolution calendar, history does not record the *creation* of any calendar, but only the correction, reformation, or amendment of pre-existing calendars. Dr. Mahler pointed out in a paper read to the Oriental Congress of 1892 ("Das Kalenderwesen der Babylonier") that the Lunar cycle was in use by the Jews at Babylon before it was adopted by the Greeks, and that it was really of Babylonian origin. In discussing the order of the intercalary months, Al Biruni (A.D. 973–1048) (*The Chronology of Ancient Nations*) mentions one particular order which he says is preferred by the Jews, because they attribute its invention to the Babylonians.*

In this attempt to explain the Jewish calendar dates in the

* The period we are dealing with was only about sixty years after the Captivity, and it is reasonable to suppose that some of the colonists at Syene may have migrated from Babylon, as Professor Sayce particularly indicates Babylonish names among those mentioned in the documents.

papyri, it may therefore be justifiable to assume that the nineteen-year Lunar cycle was in current use. I have accordingly adopted the cycle with the same intercalations as are to be found in the present Jewish calendar, which is unchanged since the fourth century A.D., and upon this basis I have constructed a table for the whole period covered by the MSS., the intercalary months disposed according to Scaliger's rule, "ter, ter, bis, ter, ter, ter, bis." *

Normal Lunar Cycle.

No of Year.		Days.
1		354
2		354
3	Emb.	384
4		354
5		355
6	Emb.	384
7		354
8	Emb.	384
9		354
10		355
11	Emb.	384
12		354
13		354
14	Emb.	384
15		355
16		354
17	Emb.	384
18		354
19	Emb.	384

Applying this tentative calendar to the cases of papyri E., B.C. 446, and J., B.C. 416, it will be seen that there is *only one possible* position for those years in this Lunar cycle, and that B.C. 446 was the 17th and B.C. 416 the 9th year of that cycle, for this is the only position in which twelve intercalary years can be brought into a period of thirty years.

This gives coincidence between the number of days from B.C. 446 November 17 to B.C. 416 December 16, and the number of days in thirty Jewish years beginning with cycle No. 17 and ending with cycle No. 8 inclusive. On any other calculation there would be a difference of a month, and both deeds could not be dated in the same month Chisleu.

B.C. 446 Nov. 17 to B.C. 416 Dec. 15 inclusive = 10,987 days
30 Jewish years, cycle No. 17 to cycle No. 8 inclusive = 10,986 „

* In the old Chinese and Japanese calendar the intercalary months are disposed in this order.

It should be mentioned in explanation that were Dr. Mahler's Babylonian cycle employed, then B.C. 446 would be the 6th and B.C. 416 the 17th year of that particular cycle. So again in the cycle which Al Biruni says was preferred by the Jews, B.C. 446 would be the 14th and B.C. 416 the 6th year.

The table appended to this paper of the 1st day of Tishri from B.C. 523 to B.C. 406 has been constructed in the following manner:— The Lunar cycle numbers are laid down for the whole period from the numbers fixed for B.C. 446 and B.C. 416, and the days of each Jewish year appended. The Jewish astronomical computation of the length of a Lunar cycle is 6939 days 16 hours and 595 chalakim.* As the table extends over six cycles, an empirical correction had to be made making some cycles 6940 days, so that the mean length of the six cycles is 6939 days 16 hours.†

It was then necessary to find reliable data for determining the 1st day of Tishri for any year, so that a calendar could be constructed so far on a sound basis. Fortunately this was afforded by the most interesting discovery a few years ago by Father Strassmeier of a Babylonian tablet recording a partial lunar eclipse at Babylon in the 7th year of Cambyses. This cuneiform tablet has been fully translated and discussed by Oppert (*Zeitschrift für Assyriologie*, vol. vi.). It has an entirely unique interest, as it is an account of one of the eclipses recorded by Ptolemy in the Almagest.

Ptolemy states that the eclipse occurred in the 7th year of Cambyses, in the 225th year of Nabonassar, on the night of the 17th and 18th of the Egyptian month Phamenoth. Strassmeier's Babylonian tablet gives the date as the 7th year of Cambyses, on the 14th day of the Jewish month Tammuz. The Julian date of the eclipse is determined by Pingré and Oppolzer as B.C. 523 July 16.

From this it is easy to calculate the date of the 1st Tishri as September 29; and as the 7th year of Cambyses is well identified as B.C. 523, the table appended is calculated entirely from this date—from B.C. 523 to B.C. 406. It gives the Year B.C.—Julian period — No. in Lunar cycle—Days in each year — Julian date of 1st Thoth—Julian date of the 1st Tishri; and Greenwich Mean Time of New Moon nearest to the 1st Tishri taken from Ginzel's *Handbuch der Mathematischen und Technischen Chronologie.*

In considering the coincidence of Julian and Jewish dates, it should be remembered that the Jewish day is defined in Genesis: "And there was evening and there was morning, one day,"—that is to say, the day begins at 6 o'clock in the evening and goes on to 6 o'clock the next evening, consequently one Jewish date extends over part of two Julian days.

* 1080 chalakim equal 1 hour.

† I have avoided complicating the question by reference to the "regular," "deficient," and "abundant" years, as exactitude is impossible, and it seemed sufficient to secure the correctness of the mean Lunar cycle.

Discussion of Dates.

A.

15th year of Xerxes	... B.C. 471 ...	1st Thoth	... Dec. 19
		28th Pachons	... Sept. 12
		1st Tishri	... Sept. 24
		18th Elul	... Sept. 12

B.

1st year of Artaxerxes	... B.C. 464 ...	1st Thoth	... Dec. 17
		6th Thoth	... Dec. 22
		1st Tishri	... Oct. 6
		18th Chisleu	... Dec. 21

C.

This papyrus is too much injured for the dates to be deciphered. The authors state that it is written by the same scribe as D., and that there is strong evidence for considering both C. and D. as of the same date.

D.

The MS. states: "On the 21st Chisleu, that is the 1st Mesore, the 6th year of Artaxerxes the king." By no possibility can these dates—21st Chisleu and 1st Mesore—be harmonised. But there is a crease in the papyrus just before the words "1 Mesore," and in this crease there is an indication of a character which cannot be deciphered until the crease is flattened out. It is probable that the Egyptian date has not been correctly deciphered. Mesore is the last month of the Egyptian year, and it is followed by the five Epagomenæ, which were kept as feast days. The question may be asked, whether in dating deeds such as those under consideration the five Epagomenæ were not treated as continuous dates of the previous month, Mesore? Dr. Budge informs me that he has no experience of such a case, but he sees no reason why it should not be suggested. I venture to hazard the suggestion that the first Epagomene was designated as the 31st Mesore. Upon this pure assumption we should have, as the best that can be done for D.,—

B.C. 460 ...	1st Thoth	... Dec. 16
	31st Mesore	... Dec. 11
	1st Tishri	... Sept. 21
	21st Chisleu	... Dec. 9

E

19th year of Artaxerxes	... B.C. 446 ...	1st Thoth	... Dec. 13
		10th Mesore	... Nov. 17
		1st Tishri	... Sept. 17
		3rd Chisleu	... Nov. 17

F.

25th year of Artaxerxes ...	B.C. 440 ...	1st Thoth	... Dec.	11
		19th Pachons	... Aug.	26
		1st Tishri	... Oct.	10
		14th Ab	... Aug.	25

G.

The papyrus is very mutilated. The dates 26th Tishri and 6th Epiphi are fairly certain, but the regnal year of Artaxerxes is conjecture. The authors state that the date of this deed cannot be earlier than 446, and hardly later than 440. We have to find coincidence between 6th Epiphi and 26th Tishri. The table gives the following dates:—

B.C. 446	6th Epiphi ...	Oct. 14	26th Tishri ...	Oct. 12
445		,, 13		,, 30
444		,, 13		,, 19
443		,, 13		Nov. 7
442		,, 13		Oct. 28
441		,, 12		,, 16
440		,, 12		Nov. 4

From this it is probable that the year is B.C. 446, and this conclusion is supported by the fact that the scribe of G. is also the scribe of E., which is clearly B.C. 446. The regnal year would thus be the 19th of Artaxerxes.

H.

The papyrus states, "in the month Elul, that is Payni, the 3rd (4th ?) year of Darius."

3rd year of Darius	Payni	began	Sept. 2	ended	Oct.	1
B.C. 421	Elul	,,	Sept. 11	,,	Oct.	9
4th year of Darius	Payni	began	Sept. 2	ended	Oct.	1
B.C. 420	Elul	,,	Aug. 31	,,	Sept.	28

Clearly the 4th year of Darius, B.C. 420, suits the case best.

J.

8th year of Darius ...	B.C. 416 ...	1st Thoth	... Dec.	5
		12th Thoth	... Dec.	16
		1st Tishri	... Oct.	15
		3rd Chisleu	... Dec.	15

K.

14th year of Darius ...	B.C. 410 ...	1st Thoth	... Dec. 4	... B.C.	411
		9th Athyr	... Feb. 10	... B.C.	410
		1st Tishri	... Sept. 20	... B.C.	411
		24th Shebat	... Feb. 8	... B.C.	410

The final results are as follows:—

		Julian Date from Egyptian.	Computed Date from Table.
A.		Sept. 12	Sept. 12
B.		Dec. 22	Dec. 21
C.	Mutilated.		
D.	Uncertain.	Dec. 11?	Dec. 9?
E.		Nov. 17	Nov. 17
F.		Aug. 26	Aug. 25
G.		Oct. 14	Oct. 12
H.	B.C. 420		
J.		Dec. 16	Dec. 15
K.		Feb. 10	Feb. 8

The above results are too near coincidence to be fortuitous, and, so far as the civil year is concerned, they refute the opinion that the commencement of the month was determined by the appearance of the new moon.

Two conclusions from the foregoing investigation may be safely hazarded: first, that the Lunar cycle of 19 years was in use in the Jewish calendar at this remote period, which, as Professor Sayce says, was little more than a century after the grandfathers and great-grandfathers of the parties mentioned in the papyri had fled into Egypt with Jeremiah; and secondly, that the order of intercalation at that time was not dissimilar to that in use to-day.

In drawing any conclusions, one may put aside possible errors of the scribe. It is highly improbable that in the first line of original and important deeds like these papyri the scribe would make such errors as would be common in copies.

These deductions do not harmonise with the views of the late distinguished chronologist M. Oppert. It may be assumed that what was current with the Jews at Babylon during the Captivity would have been continued by them in their subsequent migration. M. Oppert states that the apparition of the crescent moon signalised the commencement of the month, and in a paper "Sur l'ancien Calendrier Perse,"* he claims to have proved that the Babylonians had no fixed system for their calendar until after the year B.C. 367; that prior to that period the 19-year cycle was in use, but the intercalary months were inserted without any order, and solely on astrological grounds; and that it was the Greek influence which gave to Babylon a fixed system, assigning to each year of the cycle its particular character, whether common or embolismic, and he denies the correctness of Dr. Mahler's conclusions.

This view can hardly be sustained, for in making the Babylonian date B.C. 523, 14th Tammuz, the basis of the appended table, it is most improbable that we should arrive at such coincidence of the Egyptian and Jewish dates of the papyri if there had been no fixed system at all. The table connects in a systematic manner

* Oriental Congress, 1897. In this paper he calculates October 6th as the 1st day of Tishri, B.C. 521, as it is found in the present table.

Babylonian dates with the dates used by the Jews at Syene over a century later; and, notwithstanding M. Oppert's characteristic remark that "on fait l'histoire avec les livres historiques et non pas avec les éclipses," the rock upon which this investigation is built is the lunar eclipse at Babylon in the 7th year of Cambyses.

Table of the 1st Tishri from B.C. 523 *to* B.C. 406.

Year B.C.	Julian Period.	Lunar Cycle.	Days.	1st Thoth.	1st Tishri.	G.M.T. New ☾.
523	4191	16	354	Jan. 1	Sept. 29	Sept. 27·57
522	2	17	384		Sept. 18	17·05
521 β	3	18	354	Dec. 31	Oct. 6	5·13
520	4	19	384		Sept. 25	24·80
519	5	1	354		Oct. 14	13·85
518	6	2	354		Oct. 3	3·27
517 β	7	3	384	Dec. 30	Sept. 21	21·41
516	8	4	354		Oct. 10	10·16
515	9	5	355		Sept. 29	29·17
514	4200	6	384		Sept. 19	18·46
513 β	1	7	354	Dec. 29	Oct. 7	6·47
512	2	8	384		Sept. 26	26·11
511	3	9	354		Oct. 15	15·18
510	4	10	355		Oct. 4	4·77
509 β	5	11	384	Dec. 28	Sept. 23	23·13
508	6	12	354		Oct. 12	11·95
507	7	13	354		Oct. 1	30·93
506	8	14	384		Sept. 20	20·02
505 β	9	15	355	Dec. 27	Oct. 8	7·91
504	4210	16	354		Sept. 28	27·41
503	1	17	384		Sept. 17	17·07
502	2	18	354		Oct. 6	6·15
501 β	3	19	384	Dec. 26	Sept. 24	24·69
500	4	1	355		Oct. 13	13·61
499	5	2	354		Oct. 3	2·72
498	6	3	384		Sept. 22	21·72
497 β	7	4	354	Dec. 25	Oct. 10	9·50
496	8	5	355		Sept. 29	28·81
495	9	6	384		Sept. 19	18·38
494	4220	7	354		Oct. 8	7·47
493 β	1	8	384	Dec. 24	Sept. 26	26·10
492	2	9	354		Oct. 15	15·12
491	3	10	355		Oct. 4	4·45
490	4	11	384		Sept. 24	23·51
489 β	5	12	354	Dec. 23	Oct. 12	11·25
488	6	13	354		Oct. 1	30·34
487	7	14	384		Sept. 20	Sept. 19·72

Year B.C.	Julian Period.	Lunar Cycle.	Days.	1st Thoth.	1st Tishri.	G.M.T. New ☾.
486	4228	15	355	Dec. 23	Oct. 9	Sept. 8·77
485 β	9	16	354	Dec. 22	Sept. 28	27·42
484	4230	17	384		Sept. 17	17·06
483	1	18	354		Oct. 6	6·03
482	2	19	384		Sept. 25	25·26
481 β	3	1	355	Dec. 21	Oct. 13	13·04
480	4	2	354		Oct. 3	2·03
479	5	3	384		Sept. 22	21·21
478	6	4	354		Oct. 11	10·15
477 β	7	5	355	Dec. 20	Sept. 29	28 72
476	8	6	384		Sept. 19	18·41
475	9	7	354		Oct. 8	7·47
474	4240	8	384		Sept. 27	26·91
473 β	1	9	354	Dec. 19	Oct. 15	14·78
472	2	10	355		Oct. 4	3·81
471	3	11	384		Sept. 24	22·83
470	4	12	354		Oct. 13	11·67
469 β	5	13	354	Dec. 18	Oct. 1	30·08
468	6	14	384		Sept. 20	19·71
467	7	15	355		Oct. 9	8·78
466	8	16	354		Sept. 29	28·40
465 β	9	17	384	Dec. 17	Sept. 17	16·77
464	4250	18	354		Oct. 6	5·59
463	1	19	384		Sept. 25	24·59
462	2	1	354		Oct. 14	13·35
461 β	3	2	354	Dec. 16	Oct. 2	1·54
460	4	3	384		Sept. 21	21·02
459	5	4	354		Oct. 10	10·09
458	6	5	355		Sept. 29	29·76
457 β	7	6	384	Dec. 15	Sept. 18	18·33
456	8	7	354		Oct. 7	7·25
455	9	8	384		Sept. 26	26·39
454	4260	9	354		Oct. 15	15·15
453 β	1	10	355	Dec. 14	Oct. 3	3·15
452	2	11	384		Sept. 23	22·44
451	3	12	354		Oct. 12	11·44
450	4	13	354		Oct. 1	1·08
449 β	5	14	384	Dec. 13	Sept. 19	19·72
448	6	15	355		Oct. 8	8·75
447	7	16	354		Sept. 28	28·11
446	8	17	384		Sept. 17	17·18
445 β	9	18	354	Dec. 12	Oct. 5	4·91
444	4270	19	384		Sept. 24	23·99
443	1	1	355		Oct. 13	Sept. 12·89

Year B.C.	Julian Period.	Lunar Cycle.	Days.	1st Thoth.	1st Tishri.	G.M.T. New ☾.
442	4272	2	354	Dec. 12	Oct. 3	Sept. 2·38
441 β	3	3	384	Dec. 11	Sept. 21	21·04
440	4	4	354		Oct. 10	10·12
439	5	5	355		Sept. 29	29·66
438	6	6	384		Sept. 19	18·93
437 β	7	7	354	Dec. 10	Oct. 7	6·72
436	8	8	384		Sept. 26	25·70
435	9	9	354		Oct. 15	14·49
434	4280	10	355		Oct. 4	3·78
433 β	1	11	384	Dec. 9	Sept. 23	22·35
432	2	12	354		Oct. 12	11·44
431	3	13	354		Oct. 1	1·07
430	4	14	384		Sept. 20	20·55
429 β	5	15	355	Dec. 8	Oct. 8	8·43
428	6	16	354		Sept. 28	27·48
427	7	17	384		Sept. 17	16·48
426	8	18	354		Oct. 6	5·31
425 β	9	19	384	Dec. 7	Sept. 24	23·70
424	4290	1	355		Oct. 13	12·74
423	1	2	354		Oct. 3	2·39
422	2	3	384		Sept. 22	22·03
421 β	3	4	354	Dec. 6	Oct. 10	10·01
420	4	5	355		Sept. 29	29·24
419	5	6	384		Sept. 19	18·26
418	6	7	354		Oct. 8	7·02
417 β	7	8	384	Dec. 5	Sept. 26	25·18
416	8	9	354		Oct. 15	14·12
415	9	10	355		Oct. 4	3·70
414	4300	11	384		Sept. 24	23·38
413 β	1	12	354	Dec. 4	Oct. 12	11·43
412	2	13	354		Oct. 1	30·45
411	3	14	384		Sept. 20	20·05
410	4	15	355		Oct. 9	8·81
409 β	5	16	354	Dec. 3	Sept. 28	26·80
408	6	17	384		Sept. 17	16·07
407	7	18	354		Oct. 6	5·04
406	8	19	384		Sept. 25	Sept. 24·67

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Observations of Saturn's Ring at the time of its Disappearance in 1907, made with the 40-in. Refractor of the Yerkes Observatory. By E. E. Barnard. (Plates 9, 10.)

The position of Saturn for observation of the phenomena connected with the disappearance of the ring has been unusually favourable this year, though the south declination (5°) of the planet was somewhat unfortunate for northern observers.

At the reappearance of the ring in October 1891, Saturn rose only about two hours before the Sun, and the resulting low position and the approach of daylight made it very unfavourable for the observation of such a delicate thing as the ring when it is placed edge on towards us. At that time, with the 36-in. and 12-in. refractors of the Lick Observatory, and under such conditions, I was unable to see the ring (*M.N.* for April 1892, vol. lii. p. 419).

According to Professor Hermann Struve, the following table represents the dates of the present disappearances and reappearances of the ring of Saturn.*

1907.	Apr. 17.	Disappearance.	The Earth in the plane of the rings.
,,	July 26.	Reappearance.	The Sun in the plane of the rings.
,,	Oct. 4.	Disappearance.	The Earth in the plane of the rings.
1908.	Jan. 7.	Reappearance.	The Earth in the plane of the rings.

On account of the position of Saturn in the direction of the Sun, the disappearance of the ring in April was invisible from the Earth. The reappearance in January next will be favourable for observation.

The present paper deals with the reappearance and disappearance of the ring in July and October of this year (1907). The times are central standard time, 6^h slow of G.M.T.

The unusually bad spring weather prevented early observations with the 40-in. telescope. The planet was observed, however, as frequently as the weather and other circumstances would permit. It was supposed the "reappearance" of the ring, when the Sun passed through its plane on or about July 26, would be a definite phenomenon, and that the time of this reappearance could be determined with some sort of precision. But the reappearance was a remarkably gradual phenomenon, and there was no possible means of telling when it occurred. The ring simply very slowly and gradually got brighter, and for several days it was impossible to tell that any change had taken place; and then it became bright and almost linear. It was not, however, at this time that the greatest interest lay. It was sometime previous to the reappearance of the ring that the most important phenomena were visible.

When the planet was examined on July 2 the entire surface of the ring was easily seen, though the Sun was not then shining on its visible surface. Where it was projected on the sky, the ring

* Publications of the Astronomical Society of the Pacific, No. 114, June 10, 1907.